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(54) **ELECTRONICALLY SET AND RETRIEVABLE ISOLATION DEVICES FOR WELLBORES AND METHODS THEREOF**

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E21B 47/06 (2012.01)

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CPC ***E21B 47/06*** (2013.01); ***E21B 33/1275*** (2013.01)

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CPC E21B 33/127; E21B 33/1272; E21B 33/1275; E21B 47/06
See application file for complete search history.

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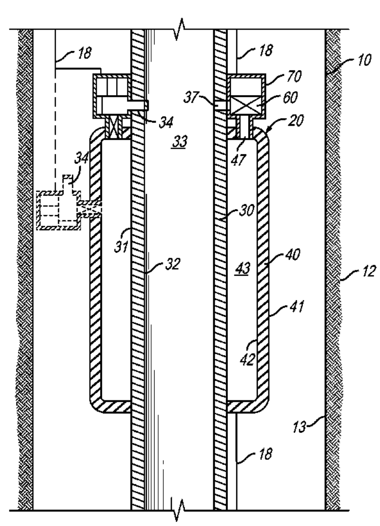
(57) **ABSTRACT**

Sealing devices such as packers comprise an expandable sealing element that is inflated and/or deflated by an electrically-activated pump disposed in a wellbore so that the sealing element can be set and retrieved from the wellbore. The pump is disposed downhole in close proximity to the expandable sealing element and is electronically associated with a surface processing unit located at the surface of the wellbore. In certain embodiments, an electric motor electronically associated with the surface processing unit drives the pump to flow a fluid into a chamber of the expandable sealing element to inflate the expandable sealing element and pumps the fluid out of the chamber of the expandable sealing element to deflate the expandable sealing element. Multiple sealing elements can be disposed on a tool or work string and all can be addressable and individually and separately controlled by the surface processing unit.

23 Claims, 6 Drawing Sheets



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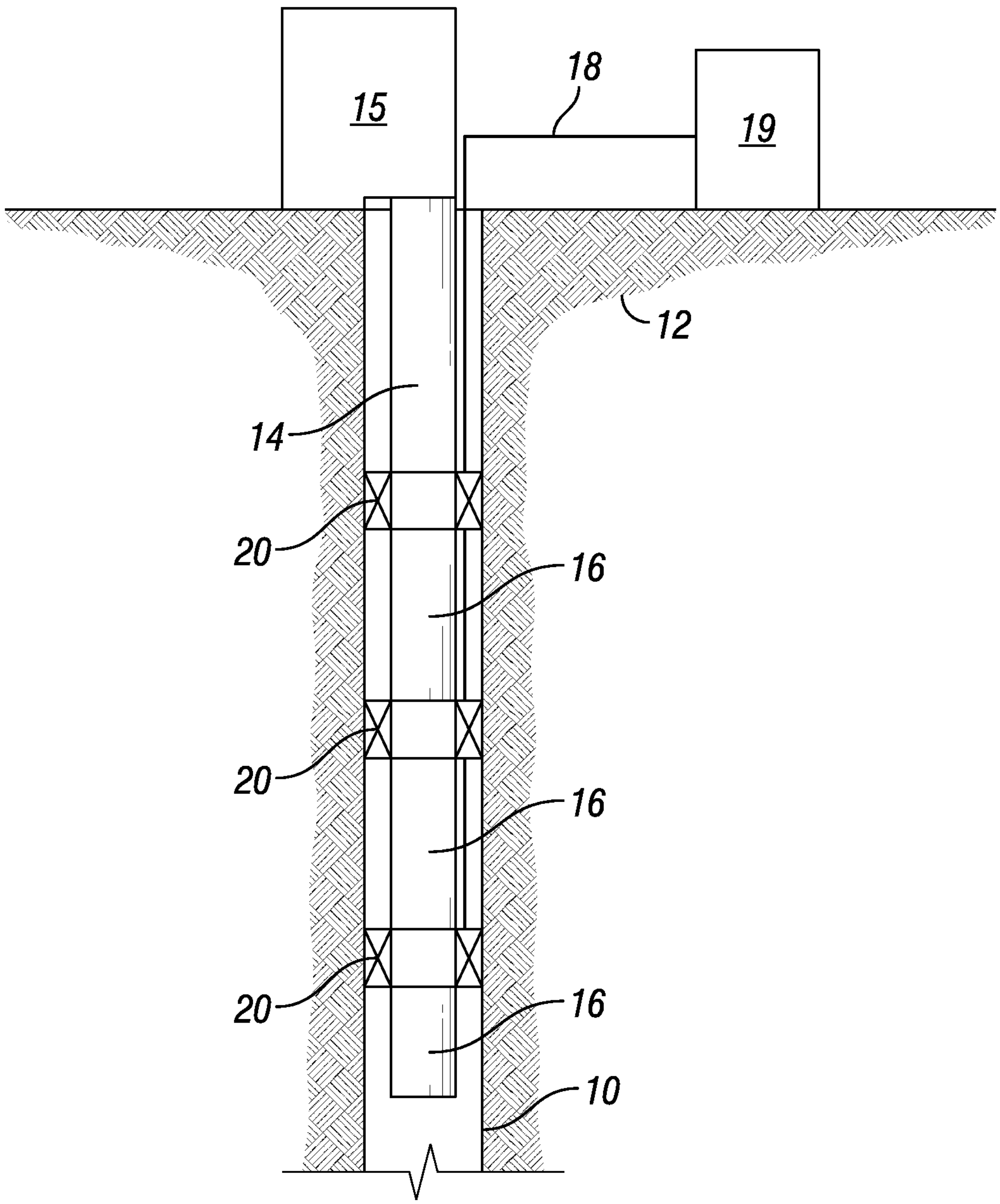


FIG. 1

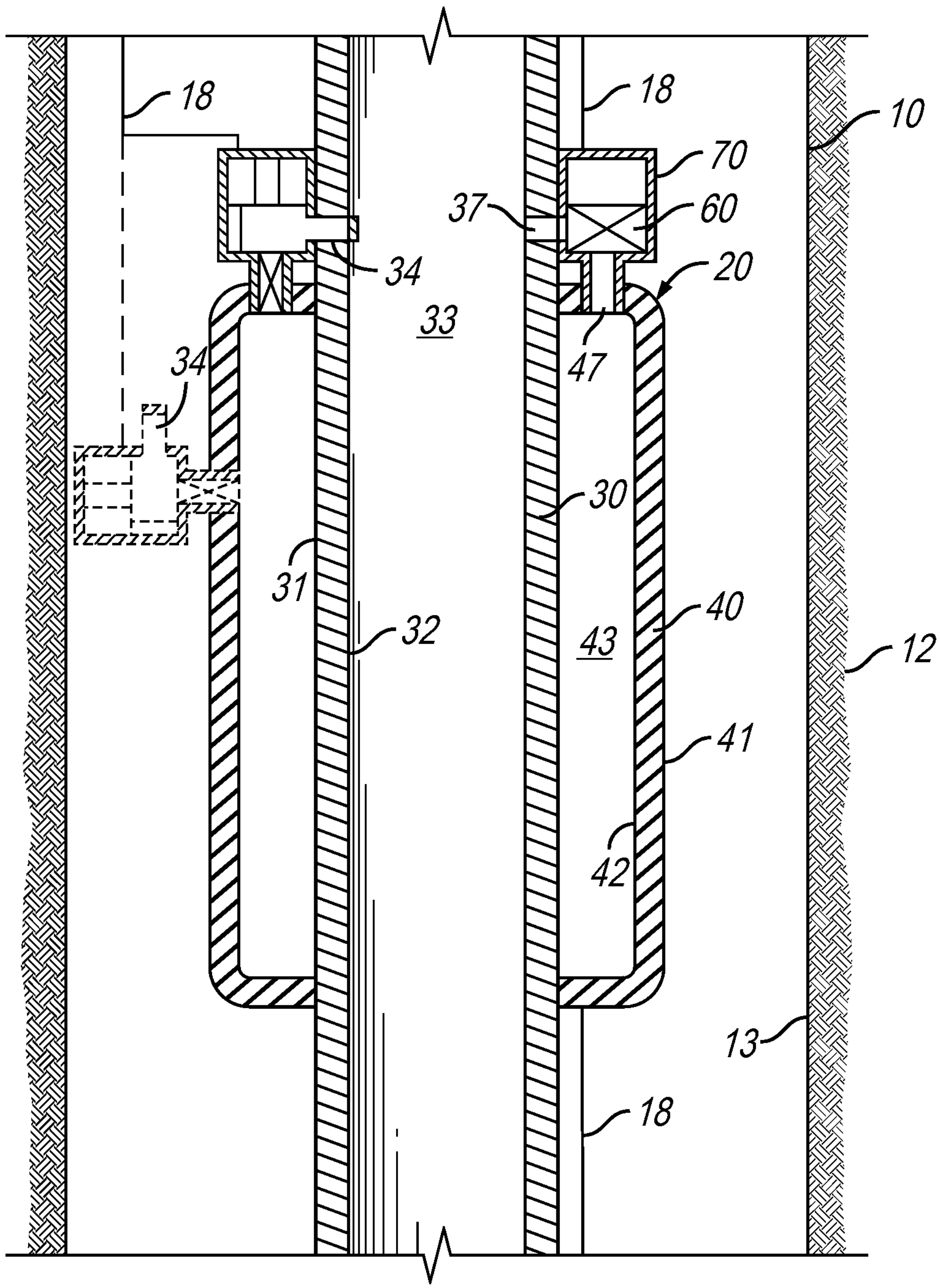
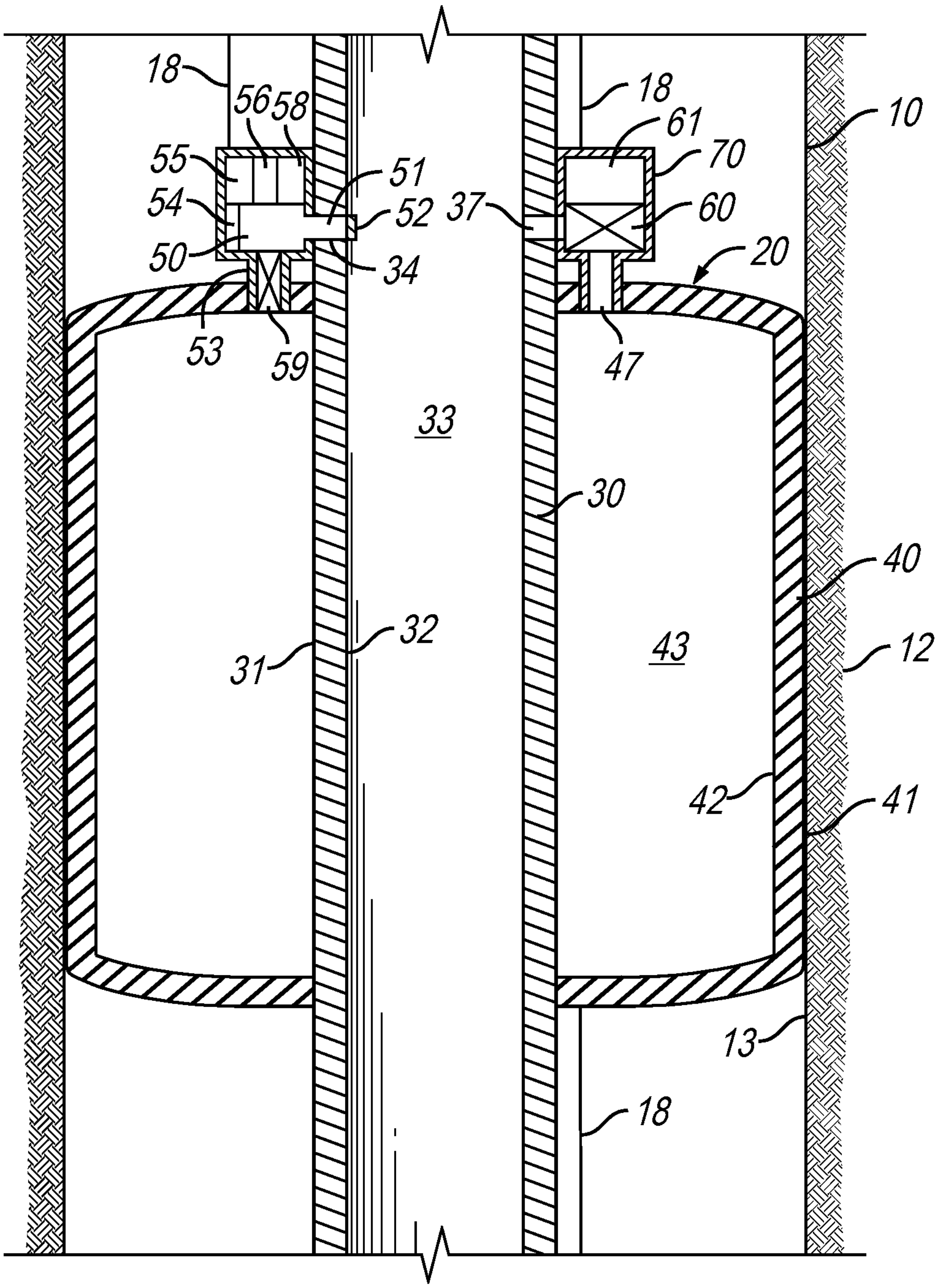


FIG. 2


18
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13
18

FIG. 3

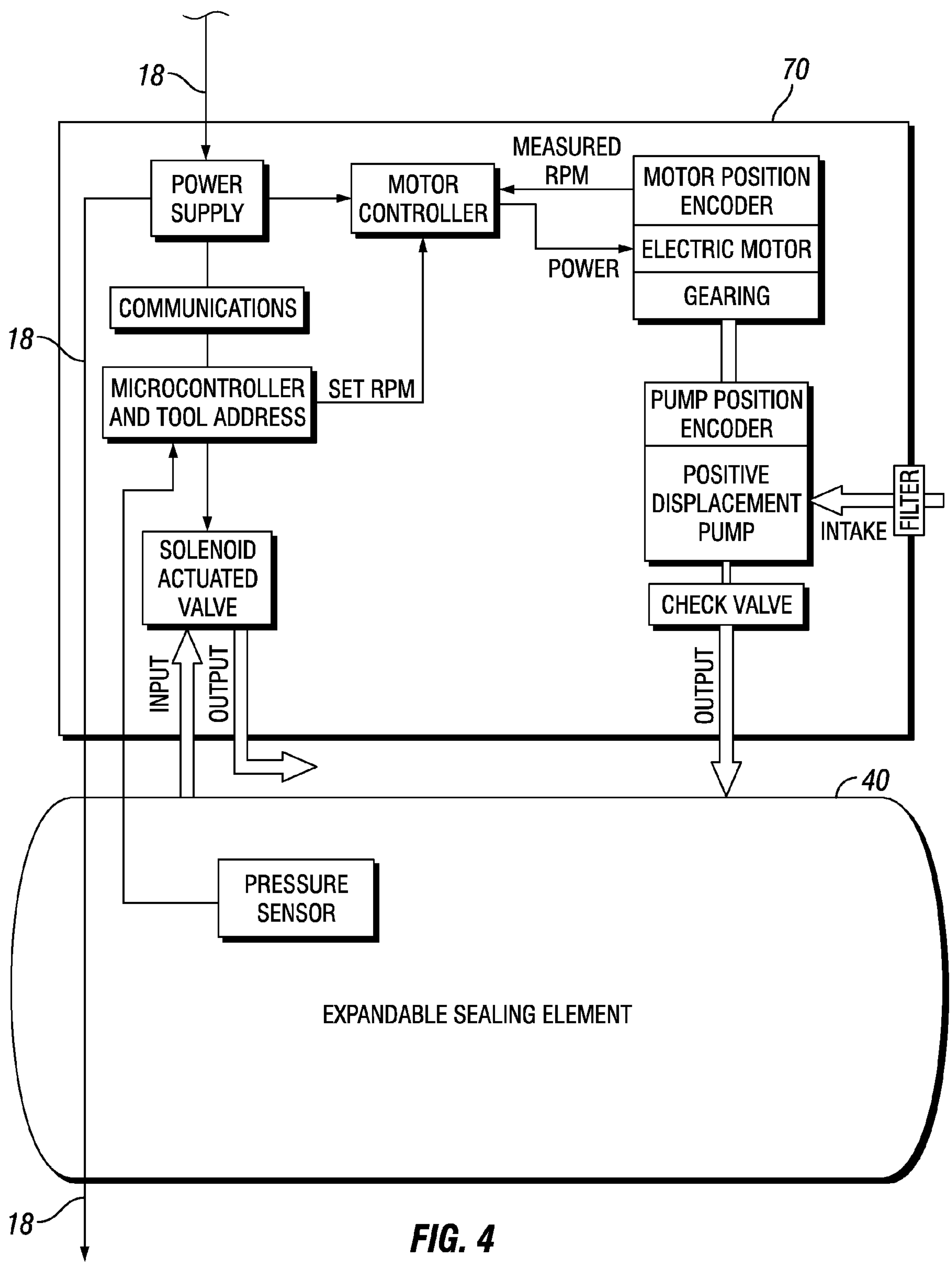
18
70
18
POWER SUPPLY
MOTOR CONTROLLER
MEASURED RPM
MOTOR POSITION ENCODER
ELECTRIC MOTOR
POWER
GEARING
COMMUNICATIONS
MICROCONTROLLER AND TOOL ADDRESS
SET RPM
PUMP POSITION ENCODER
POSITIVE DISPLACEMENT PUMP
FILTER
INTAKE
SOLENOID ACTUATED VALVE
CHECK VALVE
INPUT
OUTPUT
OUTPUT
40
PRESSURE SENSOR
EXPANDABLE SEALING ELEMENT
18

FIG. 4

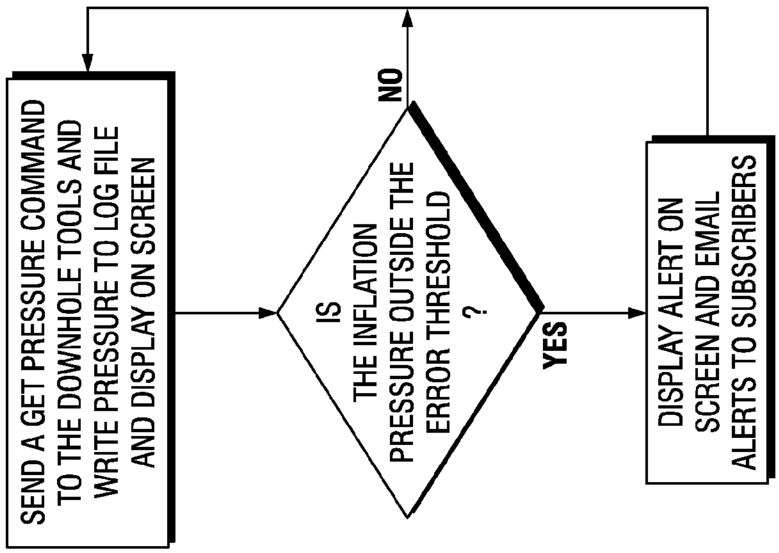
SEND A GET PRESSURE COMMAND TO THE DOWNHOLE TOOLS AND WRITE PRESSURE TO LOG FILE AND DISPLAY ON SCREEN
IS THE INFLATION PRESSURE OUTSIDE THE ERROR THRESHOLD ?
NO
YES
DISPLAY ALERT ON SCREEN AND EMAIL ALERTS TO SUBSCRIBERS

FIG. 6

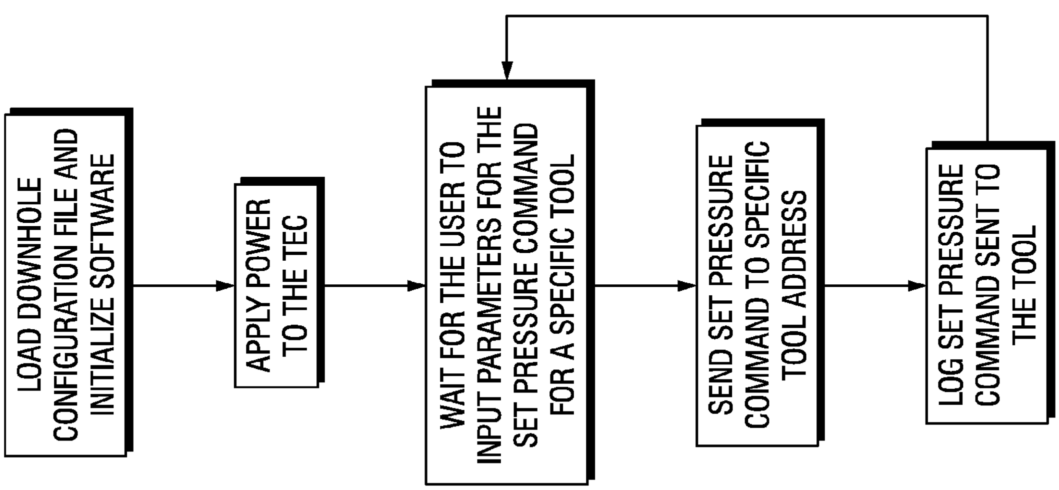
LOAD DOWNHOLE CONFIGURATION FILE AND INITIALIZE SOFTWARE
APPLY POWER TO THE TEC
WAIT FOR THE USER TO INPUT PARAMETERS FOR THE SET PRESSURE COMMAND FOR A SPECIFIC TOOL
SEND SET PRESSURE COMMAND TO SPECIFIC TOOL ADDRESS
LOG SET PRESSURE COMMAND SENT TO THE TOOL

FIG. 5

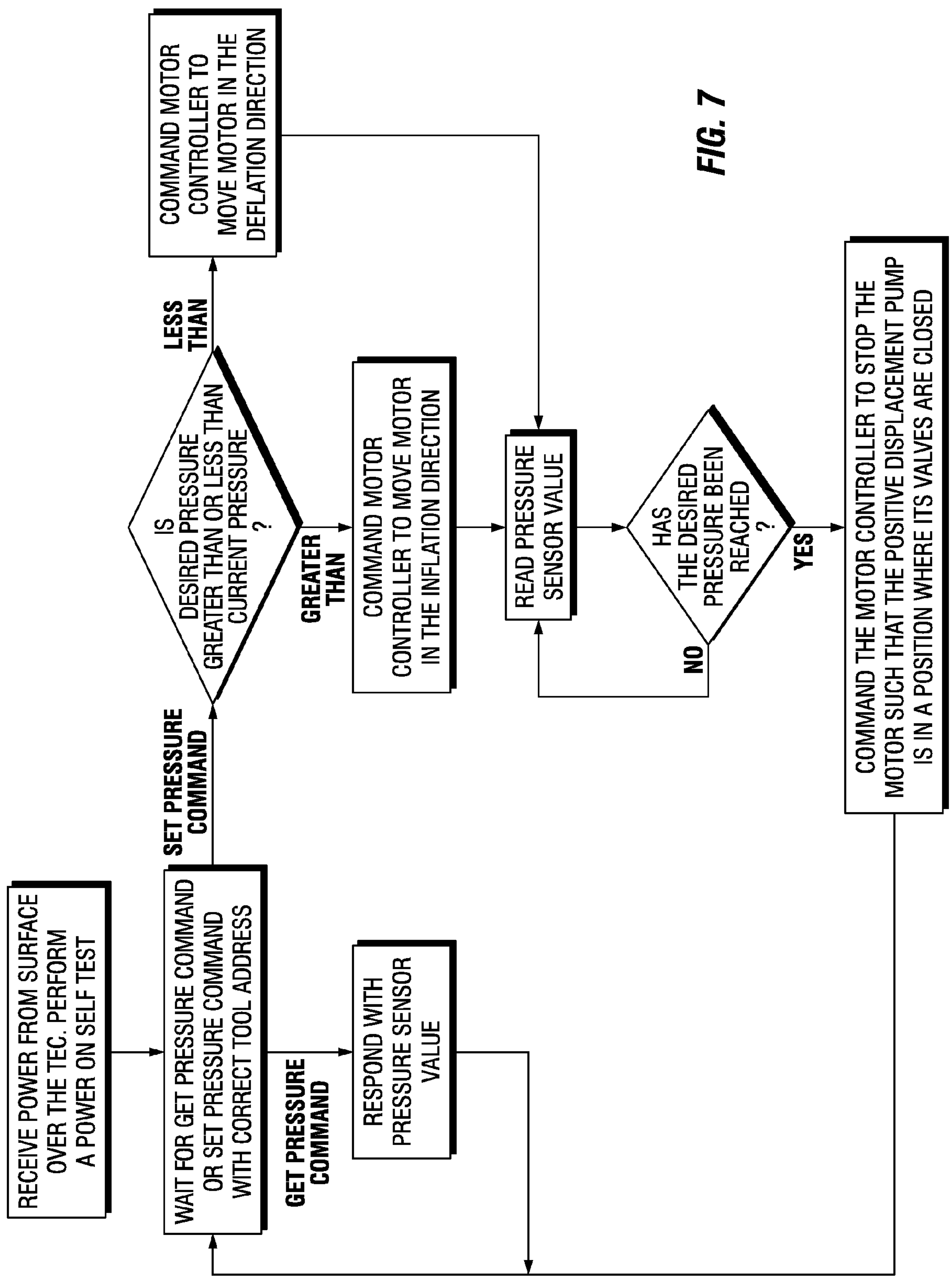
RECEIVE POWER FROM SURFACE OVER THE TEC. PERFORM A POWER ON SELF TEST
WAIT FOR GET PRESSURE COMMAND OR SET PRESSURE COMMAND WITH CORRECT TOOL ADDRESS
GET PRESSURE COMMAND
RESPOND WITH PRESSURE SENSOR VALUE
SET PRESSURE COMMAND
IS DESIRED PRESSURE GREATER THAN OR LESS THAN CURRENT PRESSURE ?
LESS THAN
COMMAND MOTOR CONTROLLER TO MOVE MOTOR IN THE DEFLATION DIRECTION
GREATER THAN
COMMAND MOTOR CONTROLLER TO MOVE MOTOR IN THE INFLATION DIRECTION
READ PRESSURE SENSOR VALUE
HAS THE DESIRED PRESSURE BEEN REACHED ?
NO
YES
COMMAND THE MOTOR CONTROLLER TO STOP THE MOTOR SUCH THAT THE POSITIVE DISPLACEMENT PUMP IS IN A POSITION WHERE ITS VALVES ARE CLOSED

FIG. 7

ELECTRONICALLY SET AND RETRIEVABLE ISOLATION DEVICES FOR WELLBORES AND METHODS THEREOF

BACKGROUND

1. Field of Invention

The invention is directed to sealing devices for isolating an annulus of an open-hole or cased oil, gas, and/or water wellbore and, in particular, to electronically set and retrievable sealing devices for use in open-hole formations that are capable of being electronically inflated and deflated.

2. Description of Art

Packers for isolating intervals and/or sealing the annulus of wellbores are known in the art. For example, some packers include an expandable elastomeric sealing element such as a rubber casing or balloon. These types of packers expand and, thus, seal to the inner wall surface of a wellbore by pumping a fluid into the rubber casing to expand the rubber casing into contact with the wellbore.

Some of these types of packers also include a swellable material within the rubber casing so that the swellable material, and not the fluid pressure itself, inflates the rubber casing. In these packers, the swellable material is contacted by hydraulic fluid or other fluid so that the swellable materials absorb the fluid and expand. In one type of these packers, for example, hydraulic fluid is pumped down a string of tubing having the packer secured thereto. The hydraulic fluid travels down the bore of the string of tubing and through a port that is in fluid communication with an inner cavity of the rubber casing. Swellable materials disposed within the rubber casing are contacted by the hydraulic fluid. As a result, the swellable materials absorb the fluid and expand. As the swellable materials expand and hydraulic fluid is pumped into the rubber casing, the rubber casing expands to seal the wellbore. After expansion, hydraulic fluid pressure is decreased and the rubber casing remains held in the expanded position solely by the swellable materials having absorbed the fluid.

Other packers are formed of an elastomeric material that is compressed or otherwise forced into the inner wall surface of the wellbore such as by expanding casing or axially compressing the elastomeric material that is disposed along an outer wall surface of the packer assembly.

SUMMARY OF INVENTION

Broadly, the sealing devices disclosed herein comprise an expandable sealing element that is inflated by a fluid being pumped into the expandable sealing element to set the sealing device in an open-hole wellbore. Thereafter, the fluid can be released from the expandable sealing element to deflate the expandable sealing element allowing the sealing device to be retrieved from the wellbore or to allow fluid to travel from outside of the zone previously isolated by the inflated expandable sealing element into the zone previously isolated by the inflated expandable sealing element. The expandable sealing element can be inflated electronically by a pump device that is capable of forcing fluid into the expandable sealing element and can be deflated by the same pump or by or in conjunction with another device such as a second pump, a one-way solenoid actuated valve, and the like.

The inflation and deflation of the expandable sealing element is controlled by an electronics package disposed on, adjacent to, or in close proximity of the sealing device. In one particular embodiment, the electronics package includes an electronic communication line in electronic communication with a downhole power supply and communications inter-

face, and a surface control device such as a computer. A motor, motor encoder, and microcontroller operatively associated with a pump and a pump position encoder can also be included as part of the electronics package. In specific embodiments, multiple sealing devices can be located along a single string, each with its own electronics package. In these specific embodiments, control systems at the surface can address and choose which sealing device to operate, independent of the other sealing device(s).

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic of an open-hole wellbore showing disposed therein a tool string having sealing devices disclosed herein.

FIG. **2** is a partial cross-sectional/partial schematic view of a sealing device disclosed herein shown in its run-in position.

FIG. **3** is a partial cross-sectional/partial schematic view of the sealing device of FIG. **2** shown in its set position.

FIG. **4** is a schematic view of the electronics and pump package of the sealing device of FIG. **2**.

FIG. **5** is a flow-chart showing start-up steps performed by software loaded into the surface processing unit and/or the microcontroller in one specific embodiment of the operation of the sealing device of FIG. **2**.

FIG. **6** is a flow-chart showing acquisition and monitoring steps performed by software loaded into the surface processing unit and/or the microcontroller in one specific embodiment of the operation of the sealing device of FIG. **2**.

FIG. **7** is a flow-chart showing inflation/deflation steps performed by software loaded into the downhole processing unit and/or the microcontroller in one specific embodiment of the operation of the sealing device of FIG. **2**.

While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

Referring now to the Figures, FIG. **1** shows a schematic of an open-hole wellbore having disposed therein sealing devices disclosed herein. As shown in FIG. **1**, open-hole wellbore **10** is disposed in formation **12** having inner wall surface **13**. Disposed in open-hole wellbore **10** is work or tool string **14** operatively associated with wellhead equipment **15**. In the embodiment of FIG. **1**, tool string **14** includes three sealing devices **20** and three fluid control valves **16**. It is to be understood, however, that less than three or more than three of each of sealing devices **20** and fluid control valves **16** can be included as part of tool string **14**. Each of sealing devices **20** and fluid control valves **16** are operatively associated with electronic communication line **18**. Electronic communication lines **18** can include a tubing encapsulated conductor ("TEC") such as those known in the art. Electronic communication line **18** is electronically associated with surface processing unit **19** which can be a computer having appropriate software installed thereon for controlling sealing devices **20** and fluid control valves **16**. Thus, surface processing unit **19** can allow a local operator located at the wellbore or remote operator using a telecommunications network to monitor the operation of sealing devices **20** and to instruct sealing devices **20** to inflate or deflate as desirable.

Referring now to FIGS. **2-3**, sealing device **20**, such as a packer, includes mandrel **30** having mandrel outer wall surface **31**, mandrel inner wall surface **32** defining mandrel bore **33**, and mandrel port **34** disposed through mandrel outer wall surface **31** and mandrel inner wall surface **32** and in fluid communication with mandrel bore **33**. In the embodiment of FIGS. **2-3**, mandrel **30** also includes deflation port **37**, although it is to be understood that deflation port **37** is not required. In embodiments that do not include deflation port **37**, sealing device **20** is moved to and from the set position by fluid flowing through an inflation port shown as mandrel port **34**. In still other embodiments (not shown), mandrel port **34** is absent and sealing device **20** is moved to and from the set position by fluid flowing through a port in fluid communication with the wellbore annulus **10**. In these embodiments, an inflation port and deflation port are in fluid communication with wellbore annulus **10** and sealing element chamber **43** (discussed below). Thus, mandrel bore **33** is isolated from sealing element chamber **43**.

Disposed on mandrel outer wall surface **31** is expandable sealing element **40**. Expandable sealing element **40** includes sealing element outer wall surface **41**, and sealing element inner wall surface **42** defining sealing element chamber **43**. Expandable sealing element **40** can be formed out of any material known in the art, including but not limited to elastomeric materials, rubber, and the like.

Although expandable sealing element **40** is shown in the particular embodiment of FIGS. **2-3** as being disposed on a mandrel of a downhole tool, it is to be understood that expandable sealing element **40** can be disposed on the mandrel of production tubing or on the mandrel of a casing string.

In addition, in certain embodiment, expandable sealing element **40** is expanded by pumping cement or other fluid down the casing and is compatible with ongoing cementing operations. Thus, expandable sealing element **40** can provide reliable zonal isolation in cemented or non-cemented completions and can be used in conjunction with liners or long-string casing.

Sealing, element chamber **43** is in selective fluid communication with mandrel port **34** by electronically activated pump **50**. Pump **50** is preferably a positive displacement pump such as those known in the art. In certain embodiments, pump **50** is reversible. Preferably, pump **50** allows full control of inflation and deflation of expandable sealing element **40**. All variations of pump **50** are known in the art.

In the embodiment of FIGS. **2-3**, pump **50** includes inlet **51** having filter or screen **52** disposed therein for filter debris out of the fluid flowing through pump **50**, and outlet **53**. Although the terms “inlet” and “outlet” are used, it is to be understood that these designations do not require that fluid always flow in a particular direction as might be suggested by the terms “inlet” and “outlet.” To the contrary, fluid can flow both directions through both inlet **51** and outlet **53** to inflate or deflate expandable sealing element **40**. Thus, pump **50** pressurizes and depressurizes expandable sealing element **40**.

In the embodiment of FIGS. **2-3**, pump **50** is operatively associated with power source **54**. Power source **54** is responsible for pulling power from electronic communication line **18** and converting the voltage from electronic communication line **18** to voltages acceptable to the electronics forming the electronics package, e.g., pump **50**, electric motor **55**, etc. Power source **54** also contains circuitry that interfaces to electronic communication line **18** to allow microcontroller **58** to encode and decode commands to and from surface processing unit **19**.

To facilitate the action of pump **50**, and to facilitate holding pump **50** in a desired position such as to keep expandable sealing element **40** in a set position (FIG. **3**), pump **50** and pump position encoder **61** in the embodiment of FIGS. **2-3** also are operatively associated with electronically activated motor **55** and motor position encoder **56**. Motor **55** can be Article 273763 35 mm Graphite Brushes Electric Motor **90** available from Maxon Motor located in Sachseln, Switzerland; and motor encoder **55** can be Model No. RMB20SC available from Renishaw Plc located in Wotton-under-Edge, United Kingdom. Motor **55** drives pump **50** and motor position encoder **56** identifies the orientation of the drive shaft (not shown) of motor **55** and communicates this orientation to the motor controller (shown schematically in FIG. **4**). Pump **50** and pump position encoder **61** are operative associated with each other. Pump position encoder **61** provides the motor controller with the orientation of pump **50** so that pump **50** will be stopped by the motor controller such that the intake and exhaust valves of pump **50** are in the closed position. In this embodiment, power source **54** is operatively associated with motor **55** and motor position encoder **56**.

In embodiments containing motor **55**, the motor controller is responsible for receiving specific revolutions per minute (RPM) commands from microcontroller **58**. The RPM commands are converted by the motor controller into motor driving signals that are sent to the electric motor inputs of motor **55**. The motor controller operatively associated with motor **55** receives position information feedback from motor position encoder **56**. This feedback allows precise closed loop control of the RPMs of motor **55** and, therefore, the inflation rate.

Also operatively associated with at least pump **50**, but can also be operatively associated with one or more of power source **54**, pump position encoder **61**, motor **55**, or motor position encoder **56** is microcontroller **58**. Microcontroller **58** can be any microcontroller known in the art that is capable of being programmed to be controlled by surface processing unit **19**, either actively or passively. In active control, surface processing unit **19** manually instructs microcontroller **58** to activate or deactivate pump **50**. In passive control, microcontroller **58** is preprogrammed to activate or deactivate pump **50** at predetermine circumstances such as pressure. In certain embodiments, microcontroller **58** is programmed with sealing device specific identifying information so that each sealing device **20** disposed on a tool or work string is addressable. That is, each sealing device **20** can be controlled and, thus, inflated or deflated, separately from any other sealing device **20** disposed on the same tool or work string. In such embodiments, microcontroller **58** listens for commands sent to its tool address and turns on or off pump **50** accordingly. In addition, microcontroller **58** can be programmed with a desired pressure of expandable sealing element **40** (received from surface processing unit **19**) and will electronically activate motor **55** to drive pump **50** to run until the desired pressure is reached. A pressure sensor (not shown) can be included to monitor the pressure within sealing element chamber **43** to turn-off pump **50** when the desired pressure is reached. Thus, using the pressure sensor for closed loop control, microcontroller **58** sends commands to pump **50**. In embodiments having electric motor **55**, microcontroller **58** sends RPM commands to the motor controller to turn on or turn off motor **55** and, thus, turn on or turn off pump **50**. As a result, the pressure within sealing element chamber **43** can be precisely controlled.

Pump **50**, motor **55**, motor position encoder **56**, and microcontroller **58** are in electronic communication with surface processing unit **19** through electronic communication line **18**. As noted above, electronic communication line **18** can be a tubing encapsulated conductor (“TEC”) or any other electronic communications line known in the art. One suitable electronic control line and its arrangement for communication with downhole tools is disclosed and described in U.S.

Pat. No. 6,173,788 issued to Lembcke, et al. which is hereby incorporated by reference herein in its entirety. In addition, the electronic communication system for controlling pump **50** and, if present, motor **55**, motor position encoder **56**, and microcontroller **58** can be any communication system known in the art. One suitable electronic communication system and its arrangement for control of downhole tools and operations is disclosed and described in U.S. Pat. No. 6,798,350 issued to Maxit, et al. which is hereby incorporated by reference herein in its entirety.

In the embodiment of FIGS. **2-3**, pump **50**, power source **54**, motor **55**, motor position encoder **56**, and microcontroller **58** are contained within housing **70** which is secured to outer wall surface **31** of mandrel **30**. It is to be understood, however, that housing **70** is not required. Instead, pump **50** and the other components, if included, can be disposed in a sub-assembly disposed above or below expandable sealing element **40** or disposed at any other location within or along mandrel **30** near-by expandable sealing element **40**.

In the embodiment of FIGS. **2-3**, outlet **53** includes valve **59**. Valve **59** can be a one-way check valve such that fluid can flow in only one direction through pump **50**, i.e., from mandrel bore **33**, through inlet **51** and through outlet **53**. In such an embodiment, deflation valve **60** disposed in fluid communication with deflation passage **47** and deflation port **37** can be included within housing **70** to facilitate removal of fluid from sealing element chamber **43** during deflation of expandable sealing element **40**. In such embodiments, deflation valve **60** is operatively associated with surface processing unit **19**, in either direction through electronic communication line **18**, or through microcontroller **58**.

In operation, a sealing device such as a packer described above with respect to FIGS. **2-3**, is placed in a tool sting and lowered into an open-hole wellbore to a desired depth. Upon reaching the desired location, an electronic signal is sent from the surface processing unit located at the wellbore surface through an electronic communication line, such as a tubing encapsulated conductor line, to the electrical pump located downhole on or adjacent the sealing device. The pump is activated due to the electronic signal and fluid is moved from outside the expandable sealing element into the sealing element chamber causing the expandable sealing element to expand or inflate. In certain embodiments, the fluid is pumped from a bore of the work or tool string carrying the sealing device. In other embodiments, the fluid is a wellbore fluid pumped from a wellbore annulus.

To facilitate activation of the pump, in some embodiments a microcontroller and/or a motor are operatively associated with the pump. In addition, a pressure sensor can also be operatively associated with the pump. In these embodiments, the motor causes the pump to flow the fluid into the sealing element chamber, the microcontroller activates and controls the RPM of the motor, and the pressure sensor detects the pressure created within the sealing element chamber and relays this information to the microcontroller. When a predetermined pressure that is programmed in the microcontroller is reached, the microcontroller shuts off the motor.

Continuous monitoring of the current pressure inside sealing element chamber **43** allows any changes to be detected which would indicate that the pressure within the sealing element chamber is leaking. If such a situation occurs, then the motor should be reactivated to pump additional fluid into the sealing element chamber.

In certain embodiments, the microcontroller is programmed with predetermined parameters such that the microcontroller performs the operation of monitoring the orientation of the motor shaft. In these embodiments, if the motor shaft moves past a predetermined position, e.g., 1-5% off from its position when the motor is turned off, the microcontroller automatically turns the motor on so that the pump can flow additional fluid into the sealing element chamber. Thus, the microcontroller facilitates ensuring that the desired pressure remains in the sealing element chamber. In a similar fashion, the pump position encoder can be monitored and any changes in position outside a threshold would cause the motor and pump to be activated.

As persons skilled in the art will recognize, the microcontroller can be programmed and reprogrammed as desired or necessary by an operator operating the surface processing unit. Similarly, the surface processing unit and the software installed thereon can be modified as desired or necessary to facilitate performance of the inflation of the expandable sealing element to the desired pressure, and maintaining the expandable sealing element at the desired inflated pressure.

As a result of inflation of the expandable sealing element, a seal is created between the outer wall surface of the expandable sealing element and a sealing surface disposed as an inner wall surface of the open-hole wellbore, e.g., on the formation itself, or on an inner wall surface of a cased wellbore. As described above, because inflation of the expandable sealing element is controlled by the pump, the pump can be held in a fixed orientation to maintain the expandable sealing element in the inflated or set position.

Thereafter, if desired, the pump can be activated by sending an electronic signal through the electronic control line to the pump to reverse direction. Alternatively, the electronic signal can be sent to the microcontroller. As a result, the pump is activated to cause fluid within the sealing element chamber to be flowed out of the sealing element chamber, either into the bore of the tool or work string containing the sealing device, or into the wellbore annulus. Thus, the pump actively causes deflation of the expandable sealing element. Deflation of the expandable sealing element can be monitored by the motor, motor position encoder, pump position encoder, pressure sensor and/or microcontroller in a similar manner as during inflation. For example, the pressure sensor can be operatively associated with the microcontroller which is programmed with a predetermined shut-off pressure at which the microcontroller sends an electronic signal to the motor or pump to stop the pump from operating.

After deflation of the expandable sealing element, the sealing device can be re-located within the wellbore by moving the tool or work string upward or downward within the wellbore and the process of inflation repeated. Alternatively, the sealing device can be removed or retrieved from the wellbore.

In other alternative methods, the sealing device can be deflated to allow fluid communication between two zones of the wellbore that were previously isolated by the sealing device. For example, in an embodiment in which two or more sealing devices are included in a work or tool string, and both sealing devices are inflated to create an upper isolated zone and a lower isolated zone, the lower sealing device can be deflated to allow the upper and lower isolated zones to be placed in fluid communication with each other. Such a situation may be desirable where a well completion including fluid flow control valve disposed in the tool or work string below the lower sealing device fails and fluids desired to be flowed out of the wellbore from the lower zone are trapped. In such a situation, the lower sealing device can be deflated to allow the trapped fluid to flow from the lower zone into the upper zone where a functioning fluid control valve can flow the previously trapped fluid through the tool or work string without the need for an intervention operation or recompletion of the well.

In other embodiments, the sealing devices can be used as part of a casing string which is run into a cased wellbore. Cement is then pumped downhole to create a plug in the wellbore. Water is then pumped down on top of the cement. Alternatively, water or other fluid may be disposed within the well due to seepage from the formation or through the cement plug. Thereafter, the pump is activated through one or more of the methodologies discussed above to cause the water or other fluid to be pumped into the sealing chamber of the expandable sealing element causing the expandable sealing element to inflate and seat against an inner wall surface of the wellbore. Disposing the sealing device above the cemented plug mitigates gas migration from reaching the surface of the well that might otherwise have migrated through microfractures contained in the cement plug. To further reduce gas migration to the surface, a second cement plug can be installed above the sealing device to provide greater mitigation of gas migration.

Referring now to FIGS. **5-7**, operation of the sealing devices can be controlled by software loaded into one or both of the surface processing unit or the microcontroller. Referring to FIG. **5**, software is loaded into the surface processing unit that is capable of storing instructions for the downhole configuration of the sealing device being disposed in the wellbore. Power is then applied to the electronic communication line, e.g., the tubing encapsulated conductor ("TEC"). The operator can then input parameters for the "Set Pressure Command" for each sealing device. The "Set Pressure Command" parameters include the pressure at which the sealing device is to be inflated or deflated. The "Set Pressure Command" is then sent from the surface processing unit to the specific sealing device as determined by the sealing device's unique "address." The pressure parameter is then logged on the surface in the configuration file of the surface processing unit for use in the surface acquisition loop (FIG. **6**).

Referring to FIG. **6**, software loaded into the surface processing unit also instructs the microcontroller to activate the motor, which in turn activates the pump. As a result, fluid is pumped into the expandable sealing element unit until the "set pressure" is reached. The software in the surface processing unit monitors the pressure as determined by a pressure sensor operatively associated with the expandable sealing element. If the pressure reading by the pressure sensor that is being communicated to the surface processing unit is outside of an error threshold, an alert is displayed at the surface processing unit so that corrective action can be taken by the operator. For example, the operator can cause the software in the surface processing unit to send a signal to the microcontroller to activate or inactivate the motor and, thus, the pump, causing modification of the pressure within the expandable sealing element. In an alternative embodiment, the microcontroller can be programmed by software to automatically turn-on or turn-off the motor and, thus, the pump to modify the pressure within the expandable sealing element. In addition to alerting the operator at the surface processing unit, the alert can also be sent over wireless communication networks, e.g., cell phone, WiFi and the like, to alert operators located remotely from the surface processing unit.

As illustrated in FIG. **7**, software loaded into the microcontroller is operatively associated with the surface processing unit. The microcontroller receives either a "Set Pressure Command" or a "Get Pressure Command." Upon receiving a Set Pressure Command, the software in the microcontroller compares the "set pressure" parameter of the Set Pressure Command to the actual or current pressure within the expandable sealing device. If the "set pressure" of the Set Pressure Command is less than the pressure reading of the expandable sealing element provided by the pressure sensor, then the microcontroller activates the motor and the pump to deflate the expandable sealing element until the desired set pressure is reached. If the "set pressure" of the Set Pressure Command is greater than the pressure reading of the expandable sealing element provided by the pressure sensor, the microcontroller activates the motor and the pump to inflate the expandable sealing element until the desired pressure is reached. The pressure sensor operatively associated with the expandable sealing element provides feedback to the microcontroller so that the pressure within the expandable sealing element can be compared to the Set Pressure Command. After the desired pressure, i.e., the "set pressure," is reached, the microcontroller stops the motor, closes the valves of the pump, and holds the sealing device in the set position (FIG. **3**).

With continued reference to FIG. **7**, upon receiving a Get Pressure Command, the downhole microcontroller responds to the surface with the current pressure sensor reading. This command is used by the surface processing unit acquisition loop shown in FIG. **6**.

It is to be understood that the invention is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. For example, the housing containing the pump and, if included, the motor, microcontroller, etc. can be included within its own separate sub assembly that is releasably secured within the work or tool string. Alternatively, these components can be included in a collar releasably or permanently secured to the mandrel. Moreover, the pump is not required to cause inflation of the expandable sealing element. Instead, a burst disk and check valve along with hydrostatic pressure can be used to inflate the expandable sealing element and the pump can be used to deflate the expandable sealing element. In addition, the sealing device is not required to be a packer, or a packer as described with respect to FIGS. **1-3**. The sealing device may be any other downhole tool that provides a seal between the downhole tool and an inner wall surface of an opened-hole wellbore. The sealing device may also be part of any other downhole tool that provides compression to create a seal between two surfaces, regardless of whether the seal isolates an opened-hole wellbore. Moreover, filter or screen **52** on pump **50** is not required. In addition, the inlet of the pump is not required to be in fluid communication with the bore of the mandrel. Instead, the inlet of the pump can be in fluid communication with the wellbore. Further, the fluid used to inflate the expandable sealing element can be any desired fluid including wellbore fluid, hydraulic fluid, cement, and the like. In addition, the pump can be used to inflate, deflate, or both inflate and deflate the expandable sealing element. Accordingly, the invention is therefore to be limited only by the scope of the appended claims.

What is claimed is:

1. A sealing device for use in an open-hole wellbore to isolate an annulus of the open-hole wellbore, the sealing device comprising:

a mandrel having a mandrel outer wall surface, and a mandrel inner wall surface defining a mandrel bore;

an expandable sealing element disposed on the mandrel outer wall surface, the expandable sealing element having a sealing element outer wall surface, a sealing element inner wall surface defining a sealing element chamber, a run-in position, and a set position, the sealing element chamber being in selective fluid communication with a mandrel or annulus port, the port being in fluid communication with a fluid source, said set position has said sealing element contacting the open hole wellbore for annulus isolation as between opposed ends of said sealing element;

an electrically-activated pump operatively associated with the port and the sealing element chamber and located outside said mandrel bore, the electrically-activated pump having an inlet in fluid communication with the fluid source through the port, and an outlet in fluid communication with the sealing element chamber; and

a power source mounted adjacent to said sealing element and located outside said mandrel bore and operatively associated with the electrically-activated pump,

wherein the electrically-activated pump transports a fluid from the fluid source through the inlet, out of the outlet, and into the sealing element chamber to inflate the expandable sealing element from the run-in position to the set position, and

wherein the electrically-activated pump transports the fluid from the sealing element chamber through the outlet, and out of the inlet to deflate the expandable sealing element from the set position toward the run-in position.

2. The sealing device of claim **1**, wherein the electrically-activated pump is capable of holding the expandable sealing element in the set position.

3. The sealing device of claim **1**, further comprising a valve disposed in the outlet to facilitate movement of the fluid from the sealing element chamber through the outlet, and through the inlet.

4. The sealing device of claim **1**, wherein the port is disposed through the mandrel outer wall surface and the mandrel inner wall surface and in fluid communication with the mandrel bore, and the fluid source comprises the mandrel bore.

5. The sealing device of claim **1**, wherein the electrically-activated pump and the power source are in electronic communication with a processing unit in electronic communication with an electronic communication line.

6. The sealing device of claim **1**, further comprising a valve disposed in a deflation passage, the deflation passage being in selective fluid communication with the fluid source and the sealing element chamber by the valve for selective deflation of the expandable sealing element from the set position toward the run-in position.

7. The sealing device of claim **6**, wherein the valve is a solenoid actuated valve in electronic communication with a processing unit.

8. A sealing device for use in an open-hole wellbore to isolate an annulus of the open-hole wellbore, the sealing device comprising:

a mandrel having a mandrel outer wall surface, and a mandrel inner wall surface defining a mandrel bore;

an expandable sealing element disposed on the mandrel outer wall surface, the expandable sealing element having a sealing element outer wall surface, a sealing element inner wall surface defining a sealing element chamber, a run-in position, and a set position, the sealing element chamber being in selective fluid communication with a mandrel or annulus port, the port being in fluid communication with a fluid source, said set position has said sealing element contacting the open hole wellbore for annulus isolation;

an electrically-activated pump operatively associated with the port and the sealing element chamber, the electrically-activated pump having an inlet in fluid communication with the fluid source through the port, and an outlet in fluid communication with the sealing element chamber; and

a power source operatively associated with the electrically-activated pump,

wherein the electrically-activated pump transports a fluid from the fluid source through the inlet, out of the outlet, and into the sealing element chamber to inflate the expandable sealing element from the run-in position to the set position, and

wherein the electrically-activated pump transports the fluid from the sealing element chamber through the outlet, and out of the inlet to deflate the expandable sealing element from the set position toward the run-in position;

wherein the port is disposed through the sealing element outer wall surface and the sealing element inner wall surface and in fluid communication with the sealing element chamber, and the fluid source comprises an annulus of the wellbore.

9. A method of sealing an open-hole wellbore to divide an annulus of the open-hole wellbore, the method comprising:

(a) electrically activating a first downhole pump located outside a bore of a mandrel and operatively associated with a first expandable sealing element of a first sealing device mounted to said mandrel causing a first fluid to flow into a chamber of the first expandable sealing element to inflate the first expandable sealing element;

(b) continuing to pump the first fluid into the chamber of the first expandable sealing element until an outer wall surface of the first expandable sealing element engages with an inner wall surface of a wellbore; and

(c) maintaining the first downhole pump in a first downhole pump stationary set position causing the outer wall surface of the first expandable sealing element to be maintained in contact with the inner wall surface of the wellbore to define a first isolated zone within the wellbore while maintaining clear said bore of said mandrel.

10. The method of claim **9**, wherein after step (c) the first downhole pump is activated causing the first fluid within the chamber of the first expandable sealing element to flow out of the chamber of the first expandable sealing element to deflate the first expandable sealing element.

11. The method of claim **9**, wherein during step (c) a wellbore fluid is flowed from a wellbore annulus through a first fluid control valve disposed in fluid communication with the first isolated zone.

12. The method of claim **9**, further comprising the steps of:

(d) electrically activating a second downhole pump operatively associated with a second expandable sealing element of a second sealing device causing a second fluid to flow into a chamber of the second expandable sealing element to inflate the second expandable sealing element;

(e) continuing to pump the second fluid into the chamber of the second expandable sealing element until an outer wall surface of the second expandable sealing element engages with the inner wall surface of the wellbore; and

(f) maintaining the second downhole pump in a second downhole pump set position causing the outer wall surface of the second expandable sealing element to be maintained in contact with the inner wall surface of the wellbore to define a second isolated zone within the wellbore.

13. The method of claim **12**, further comprising the steps of:

(g) electrically activating a third downhole pump operatively associated with a third expandable sealing element of a third sealing device causing a third fluid to flow into a chamber of the third expandable sealing element to inflate the third expandable sealing element;

(h) continuing to pump the third fluid into the chamber of the third expandable sealing element until an outer wall surface of the third expandable sealing element engages with the inner wall surface of the wellbore; and

(i) maintaining the third downhole pump in a third downhole pump set position causing the outer wall surface of the third expandable sealing element to be maintained in contact with the inner wall surface of the wellbore to define a third isolated zone within the wellbore.

14. The method of claim **13**, wherein during step (**0** a first wellbore fluid is flowed from a wellbore annulus through a first fluid control valve disposed in fluid communication with the second isolated zone.

15. The method of claim **14**, wherein after step (i) the third downhole pump is activated causing the third fluid within the chamber of the third expandable sealing element to flow out of the chamber of the third expandable sealing element to deflate the third expandable sealing element.

16. The method of claim **15**, wherein after the third expandable sealing element is deflated, flowing a second wellbore fluid from the wellbore annulus through the first fluid control valve.

17. The method of claim **16**, wherein the first fluid and the second fluid comprise the same fluid.

18. The method of claim **17**, wherein the third fluid comprises the same fluid as the first and second fluids.

19. The method of claim **12**, wherein steps (a) and (d) are selectively performed by a processing unit in electronic communication with the first downhole pump and the second downhole pump.

20. The method of claim **9**, wherein during step (c), a pressure sensor operatively associated with the first expandable sealing element communicates electronically with a processing unit electronically associated with the first downhole pump to maintain the first downhole pump in the first downhole pump set position.

21. The method of claim **9**, wherein the first fluid is flowed from a tubular bore into the chamber of the first expandable sealing element during step (a).

22. The method of claim **9**, wherein the first fluid is flowed from an annulus of the wellbore into the chamber of the first expandable sealing element during step (a).

23. The method of claim **9**, wherein during step (c) gas migration between the outer wall surface of the first expandable sealing element and the inner wall surface of the openhole wellbore is prevented.

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